

## Relative Motion Problems

1. A dog walks at 1.6 m/s on the deck of a boat that is traveling north at 7.6 m/s with respect to the water.
  - a. What is the velocity of the dog with respect to the water if it walks towards the front of the ship?
  - b. What is the velocity of the dog with respect to the water if it walks towards the back of the ship?
  - c. What is the velocity of the dog with respect to the water if it walks towards the east rail?

**(9.2 m/s [N], 6.0 m/s [N], 7.8 m/s [N 12 E])**

2. The pilot of a light plane heads due north at an air speed of 400 km/h. A wind is blowing from the west at 60 km/h.
  - a. What is the plane's velocity with respect to the ground?
  - b. How far off course would the plane be after 2.5 h, if the pilot had hoped to travel due north but had forgotten to check the wind velocity.

**(405 km/h [N 8.5° E], 150 km [E])**

3. A pilot wishes to make a flight of 300 km[NE] in 45 min. On checking with the meteorological office, she finds that there will be a wind of 80 km/h from the north for the entire flight. What heading and airspeed must she use for the flight?

**([E 52° N], 460 km/h)**

4. An airplane must travel 575 km west in 2.00 hours to its next destination. If the aircraft encounters a wind of 50.0 km/h blowing southward, what must be the airspeed and heading?

**(292 km/h, 170.1°)**

5. An airplane maintains a heading due west at an air speed of 900 km/h. It is flying through a hurricane with winds of 300 km/h, from the northeast.
  - c. In which direction is the plane moving relative to the ground?
  - d. What is the plane's ground speed?
  - e. How long would it take the plane to fly from one city to another 500 km away, along the path in (a)?

**([W 11° S], 1132 km/h, 0.44 h or 27 min)**

6. Two boathouses are located on a river, 1.0 km apart on the same shore. Two men make round trips from one boathouse to the other, and back. One man paddles a canoe at a velocity of 4.0 km/h relative to the water, and other walks along the shore at a constant velocity of 4.0 km/h. The current in the river is 2.0 km/h in the starting direction of the canoeist.
  - f. How much sooner than the walker does the canoeist reach the second boathouse?
  - g. How long does it take each to make the round trip?

**(5.0 min, 40 min and 30 min)**

7. A 70 m wide river flows at 0.80 m/s. A girl swims across it at 1.4 m/s relative to the water.

- h. What is the least time she requires to cross the river?
- i. How far downstream will she be when she lands on the opposite shore?
- j. At what angle to the shore would she have to aim, in order to arrive at a point directly opposite the starting point?
- k. How long would the trip in part (c) take?

**(50 s, 40 m, 55°, 61 s)**

8. An ocean liner is steaming at 18 km/h due south. A passenger strolling on the deck walks towards the rear of the ship at 3.0 m/s. After walking for 12 s, he turns right and walks at the same speed towards the rail, 15 m from his turning point. What is his velocity, relative to the water, while walking towards the rear? While walking towards the rail?

**(2.0 m/s [S] and 5.8 m/s [S 31° W])**

9. A pilot maintains a heading due west with an air speed of 240 km/h. After flying for 30 min, he finds himself over a town that he knows is 150 km west and 40 km south of his starting point.

- l. What is the wind velocity, in magnitude and direction?
- m. What heading should he now maintain, with the same air speed, to follow a course due west from the town?

**(100 km/h [S 37° W], [W 19° N])**

10. The navigator of an airplane plans a flight from one airport to another 1200 km away, in a direction 30 east of north. The weather office informs him of a prevailing wind from the west, of 80 km/h. The pilot wants to maintain an air speed of 300 km/h.

- n. What heading should the navigator give the pilot?
- o. How long will the flight take?
- p. How much time did the wind save?

**([N 17° E], 3.6 h, 0.40 h)**